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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/921,938 | 08/02/2001 | Ian Latchford | AMAT/4227.P1/DD/BCVD/JW | 8367 |

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| EXAMINER |
|---|
| WALKE, AMANDA C |

| ART UNIT | PAPER NUMBER |
|---|---|
| 1752 | 12 |

DATE MAILED: 02/26/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 09/921,938 | LATCHFORD ET AL. | |
| | Examiner | Art Unit | |
| | Amanda C Walke | 1752 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *16 December 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-44* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-44* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

This action is in response to the appeal brief filed 12/16/2002. The examiner has considered the arguments presented and the rejections of record have been amended accordingly. The new rejections follow.

### *Claim Rejections - 35 USC § 103*

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-7, 12-14, and 36-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al (5,830,332) in view of Lin et al ((6,087,064).

Babich et al disclose a method of the sputter deposition of hydrogenated amorphous carbon film (a-C:H). The method includes putting a substrate into a deposition chamber, providing a mixture of a hydrocarbon gas, He, H, O, and Ar gas, and heating the mixture during the deposition process at 25 degrees C or optionally from 25 to 400 degrees C, at a pressure of 1-50 mTorr and a flow rate of 1-100 sccm (column 4, line18-column 6, line 38). The target is held at a fixed dc bias voltage (from a dc power supply) of power density of 0.8 to 19.4 $W/cm^2$. The preferred compounds for use as the hydrocarbon include methane, ethane, propane, butane, acetylene, and the like, but preferably contemplated are acetylene (claim 9), methane, and ethane. The a-C:H layer may absorb DUV (248 nm or 193 nm wavelength) light and have a refractive index of 1.6 and 2.2 and has a thickness of 500 to 5000 angstroms (column 2, lines 39-54, column 3, lines 29-

42, column 7, lines 25-34). After depositing the layer on the substrate, a layer of photo resist may be applied thereon which is then exposed and developed. Then the a-C:H film is etched (RIE) with oxygen plasma, then the photo resist is removed. Alternatively, a thin metal layer may be added prior to the addition of the photo resist layer (column 7, lines 5-19 and column 11, lines 2-29). There is no teaching of the preferred thickness of the layer of photo resist, however, from the drawings the layer of resist appears to be the same thickness as the amorphous carbon layer. Therefore the layer of resist may be 500 to 5,000 angstroms thick. From example 4 it appears that the layer of photo resist is spun onto the a-C:H film as required by claim 3. The films have very low reflectivity and will reduce the unwanted flare from the reticle/mask (column 7, lines 35-37). The reference fails to provide data on the absorption coefficient at wavelengths of less than 250 nm. The absorption coefficient of a material appears to be an inherent property of the material, and appears to be related to the refractive index. The reference material appears to be similar and meets the present claim limitations for the refractive index, thus it is the position of the examiner that the material would also inherently meet the limitation for the absorption coefficient. The specification teaches that after exposure to an oxygen based etchant the photo resist layer may be used as a hard mask layer to etch the underlying layers, then the patterned amorphous carbon layer may be used as a hard mask to etch the underlying material layer. This appears to mean that the entire photoresist layer would be affected by the etchant and the entire layer would be the hard mask. The layer of photo resist is exposed to a laser to from a pattern and is developed. Then, the a-C:H layer is etched through the remaining portion of the photo resist layer by an oxygen etchant, which would form a hard mask of the outermost portions of the photo resist layer since these are the portions that would be exposed to

the oxygen etchant. Then the photo resist layer is removed (see example 4). The reference fails to specify the preferred type of photo resist used in the method.

Lin et al disclose a silicon containing photoresist material containing between 5 and 10 % silicon. The reference further teaches that the use of a silicon containing resist provides the advantages of being capable of transferring a pattern of high resolution and good image profile to the underlying layers (see column 10, lines 1-46).

Given the teaching of Lin et al, it would have been obvious to one of ordinary skill in the art to prepare a device by the method of Babich et al using the silicon containing resist of Lin et al to increase the resolution of the formed pattern with reasonable expectation of achieving a material having superior optical properties at UV and DUV.

3. Claims 10, 11, 16-26, and 30-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al in view of Lin et al and Mitani et al (6,191,463).

Babich et al and Lin et al have been discussed above, but fail to disclose a silicon oxide or nitride layer coated on the substrate prior to the deposition of the a-C:H layer.

Mitani et al disclose a method of forming a semiconductor device containing may consist of silicon oxide or silicon nitride by CVD. The use of the insulating layer improves the reliability of the material by decreasing the deterioration of the film (increasing the dielectric breakdown strength) (see column 2, lines 1-25 and 12, line 57 to column 13, line 5).

Given the teachings of Mitani et al it would have been obvious to one of ordinary skill in the art to prepare the material of Babich et al in view of Lin et al choosing the add an insulating layer of silicon oxide or silicon nitride as taught by Mitani et al to improve the reliability of the film with

reasonable expectation of achieving a material having superior optical properties at UV and DUV.

4. Claims 8, 9, 43, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al in view of Lin et al and Yang et al (6,165,695).

Babich et al and Lin et al have been discussed above, but fail to teach the use of a layer of photo resist having a thickness of less than 500 angstroms.

Yang et al disclose a method of making a semiconductor device using an ultra-thin layer of photo resist. The layer of photo resist employed in the method has a thickness of 50 to 2000 angstroms (column 3, lines 20-45). These ultra-thin resists are preferable because the limited penetration depth of the shorter wavelengths of UV requires their use so that the entire depth of the resist layer can be exposed (column 1, lines 51-63).

Given the teaching that it is known to use a layer of photo resist having any thickness in the range of 50 to 2000 angstroms, it would have been obvious to one of ordinary skill in the art to prepare the material of Babich et al in view of Lin et al and use a layer of photo resist having any thickness in the taught range, preferably at the smaller end of the range so that the entire depth of the resist can be accurately patterned by the UV light used in the method of Babich et al (including thickness of 250 angstroms or less as required by claims 8, 9, 43, and 44) with reasonable expectation of achieving a material having superior optical properties at UV and DUV.

5. Claims 27 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al in view of Lin et al, Mitani et al and in further view of Yang et al.

All references have been discussed above.

Given the teaching that it is known to use a layer of photo resist having any thickness in the range of 50 to 2000 angstroms, it would have been obvious to one of ordinary skill in the art to prepare the material of Babich et al in view of Lin et al and Mitani et al and use a layer of photo resist having any thickness in the taught range, preferably at the smaller end of the range so that the entire depth of the resist can be accurately patterned by the UV light used in the method of Babich et al (including thickness of 250 angstroms or less as required by claims 27 and 28) with reasonable expectation of achieving a material having superior optical properties at UV and DUV.

6. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al in view of Lin et al in further view of Sobczak (4,576,834).

Babich et al, Lin et al, et al have been discussed above.

Sobczak discloses a method of forming a device utilizing a oxygen RIE process. In the method of the reference, a layer of photo resist is deposited on a stack of layers coated on a substrate. The layer of resist is patterned to form an etch mask. Then the oxygen RIE process is performed which removes a portion of the photo resist in addition to removing/etching the underlying layers (which include oxide and nitride layers and a fluorocarbon layer). The reference teaches that it is known to etch the layers in a single sequence (column 6, lines 13-53).

Given the teachings of Sobczak that it is known to remove portions of the photo resist layer while etching the underlying layers during an oxygen RIE process, it would have been obvious to one of ordinary skill in the art to prepare the material of Babich et al in view of Lin et al and removing/etching a portion of the photo resist mask layer while simultaneously etching

the underlying layers with reasonable expectation of achieving a material having superior optical properties at UV and DUV.

7. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Babich et al in view of Lin et al and Mitani et al in further view of Sobczak.

All references have been discussed above.

Given the teachings of Sobczak that it is known to remove portions of the photo resist layer while etching the underlying layers during an oxygen RIE process, it would have been obvious to one of ordinary skill in the art to prepare the material of Babich et al in view of Lin et al and Mitani et al and removing/etching a portion of the photo resist mask layer while simultaneously etching the underlying layers with reasonable expectation of achieving a material having superior optical properties at UV and DUV.

***Conclusion***

8. Applicant's arguments filed 12/16/2002 have been fully considered but they are not persuasive.

Applicant has argued that the Babich fails to teach the present invention as it teaches to "strip" the resist layer off of the a-C:H layer after it is used to pattern the a-C:H layer. Even though this appears to be the case, the present claims do not require that the resist be present after the patterning of the a-C:H layer has been patterned using the resist pattern as a hard mask.

Applicant has argued that the Lin reference teach or suggest depositing a silicon containing resist layer on top of an amorphous carbon layer, then forming an in situ hard mask in an outer portion of the photo resist during an etching process through the amorphous carbon

layer, as the layer comprises 3 components and would therefore not actually contain 5-10 wt% of silicon. The Lin reference does teach that there may be other components present, it is clear that despite the content of each of the components (and it is noted that the silicon-containing component may comprise 100% of the layer), the layer MUST contain at least 5 wt% silicon or the etch resistance of the layer maybe compromised.

Also, the applicant has argued that there is no teaching in the Babich reference which teaches one of ordinary skill in the art to expect the advantages expected of applicant's claimed method which would include the formation of the in situ hard mask. The steps of the Babich reference appear to be basically the same as those of the present claims. The resist layer is taught to become a "hard mask" at the time it is exposed to the oxygen based etchant and it is belived that the entire layer would be the hard mask which would include the outer portion. The a-C:H film is etched to form a pattern and then is used as a mask to etch the underlying layers. This appears to meet the present claim limitations. Also, then the thickness of the hard mask layer would be the thickness of the photoresist layer. The Lin reference provides advantages to using its taught silicon containing resist in a pattern formation method, which provides one of ordinary skill in the art with motivation to use the resist of Lin in the method of Babich. Also, the Lin reference teaches advantages in employing its resist layer comprising at least 5 wt % silicon (5-10 preferably) therefore it provides one of ordinary skill in the art with the motivation to employ its particular resist in a method of forming a semiconductor device.

Applicant has argued that Mitani fails to teach or suggest depositing a material layer on a substrate via CVD prior to depositing an amorphous carbon layer, nor does it teach the use of a silicon containing resist. Mitani is solely relied upon for its teaching of adding a silicon oxide or

silicon nitride as an insulating film whose use improves the reliability of the material by decreasing the deterioration of the film. The reference does provide motivation for one of ordinary skill in the art to employ an insulating film to achieve this advantage in a pattern forming method.

Although the rejection has been slightly changed, all arguments presented were still relevant and addressed. Claims 1-44 are rejected.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Amanda C Walke whose telephone number is 703-305-0407. The examiner can normally be reached on M-R 5:30-4.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Janet Baxter can be reached on 703-308-2303. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Amanda C Walke
Examiner
Art Unit 1752

ACW
February 23, 2003

ROSEMARY ASHTON
PRIMARY EXAMINER